

In the Claims

Please cancel claims 1-5 without prejudice.

Please add new claims 6-13 appended hereto at
Tab 2.

In the Abstract

Please delete the originally filed Abstract and
replace it with the replacement Abstract appended hereto at
Tab 3.

REMARKS

Introduction

Applicants have amended the application to conform
the specification, claims, and abstract to United States
patent prosecution practice and to select claimed embodiments
for prosecution at this time.

Amendments of the Specification

Applicants have amended the specification by
submitting a substitute specification, attached hereto at
Tab 1, under 37 C.F.R. § 1.121(b)(3). An Appendix including
a marked-up version of the specification showing changes

relative to the specification as originally filed is provided below.

Applicants have added the heading "Background of the Invention" immediately following the application title pursuant to 37 C.F.R. § 1.77(b)(5).

Applicants have replaced a reference to the generic portion of claim 1 at page 1, paragraph 1, of the specification with explicit language from the generic portion of claim 1 in order to conform the specification to U.S. patent prosecution practice. MPEP § 608.01(1) (In establishing a disclosure, applicant may rely not only on the description and drawings as filed but also on the original claims if their content justifies it.).

Applicants have added the heading "Brief Summary of the Invention" at page 1, immediately before the fourth paragraph, pursuant to 37 C.F.R. § 1.77(b)(6).

Applicants have amended the fifth paragraph of page 1 to replace a reference to claim 1 with explicit language from claim 1 in order to conform the specification to U.S. patent prosecution practice. MPEP § 608.01(1).

Applicants have added the heading and section "Brief Description of the Drawings" at page 1, immediately

following paragraph 6 of the specification, pursuant to 37 C.F.R. § 1.77(b)(7).

Applicants have added the heading "Detailed Description of the Invention" immediately after the newly added "Brief Description of the Drawings" section pursuant to 37 C.F.R. § 1.77(b)(8).

Applicants have added a new paragraph immediately after the new heading "Detailed Description of the Invention" and immediately before the first paragraph on page 2 of the specification as filed. The new paragraph (para. no. 011 in the foregoing substitute specification) is supported by originally filed claim 1. MPEP § 608.01(1).

Applicants have amended the second paragraph of page 3 of the specification in order to properly refer to the FIG. Applicants have made similar amendments to the third paragraph on page 3, the fifth paragraph on page 3, the seventh paragraph on page 3, and the first paragraph on page 4.

Applicants have added paragraph and line numbers to the specification to facilitate the identification of text therein.

The substitute specification includes no new matter.

Amendments of the Claims

Applicants have canceled claims 1-5 without prejudice and have added new claims 6-13 having subject matter that was present in the canceled claims. Applicants respectfully reserve the right to pursue the subject matter of canceled claims 1-5, including any embodiments originally defined by improper multiple dependent claims, in one or more continuation or divisional applications. Claims 1-5 were replaced by claims 6-13 to remove improper multiple dependencies and select claimed embodiments for prosecution at this time.

Support for new claims 6-13 is provided throughout the specification as filed, particularly at page 2 and at page 3, first paragraph. Support for new claims 6-13 is also provided by the originally filed claims as summarized in the following table.

New Claim	Supporting Claim(s) (as filed)
6	1
7	1-2
8	1,3
9	1-3
10	1,4
11	1,2,4
12	1,5
13	1,2,5

The new claims include no new matter.

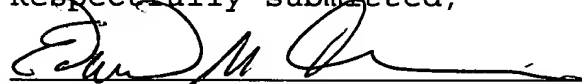
Amendment of the Abstract

MPEP § 608.01(b) requires that the Abstract be limited to a single paragraph. Applicants have amended the Abstract accordingly. The amended Abstract includes no new matter. A marked-up version of the Abstract showing changes relative to the originally filed Abstract is included in the Appendix below.

Conclusion

Applicants respectfully submit that the specification, claims, and Abstract of this application are in conformance with U.S. patent prosecution practice. Applicants respectfully request entry of the foregoing amendments. A favorable action is respectfully requested.

Respectfully submitted,



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APPENDIX

A. MARKED UP VERSION OF THE SPECIFICATION SHOWING CHANGES
MADE

PROCESS FOR FORMING TUBE-SHAPED HOLLOW BODIES MADE OF METAL

BACKGROUND OF THE INVENTION

The invention concerns a process for forming tube-shaped hollow bodies made of metal [according to the generic portion of patent claim 1.], particularly made of aluminum, with, after shaping of a slab-shaped semifinished product into a closed cross-sectional profile and straight seam welding of the opposing edges of the semifinished product, the tube-shaped hollow body formed being soft annealed and finally hydroformed in a die by a medium introduced into the hollow body.

Forming tube-shaped hollow bodies made out of metal by soft annealing the hollow body, further processing it depending on the requirements of the final shape sought, and finally hydroforming it in a die through a medium introduced into the hollow body is known.

Because the material solidifies during hydroforming as the forming progresses, and therefore resists further

shaping or even cracks, in practice, changes of only up to approximately 10% of the cross-section relative to the initial cross-section are possible during one cycle of hydroforming.

BRIEF SUMMARY OF THE INVENTION

The object of the invention is to allow greater alterations of the cross-section.

This object is achieved in a process [according to the generic portion of claim 1 by the features of this claim.] for forming tube-shaped hollow bodies made of metal, particularly made of aluminum.

Further developments and advantageous embodiments arise from the sub-claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1(a) is an elevational view of an apparatus that may be used to process a hollow body, such as that shown in partial sectional view, in accordance with the principles of the invention;

FIG. 1(b) is a partial sectional view of the body shown in FIG. 1(a) after processing in accordance with the principles of the invention;

FIG. 1(c) is a partial sectional view of apparatus that may be used to further process the body shown in FIG. 1(b), shown in partial sectional view, in accordance with the principles of the invention; and

FIG. 1(d) is a partial sectional view of the apparatus and body shown in FIG. 1(c), when the body is in a later stage of processing than that shown in FIG. 1(c), in accordance with the principles of the invention.

DETAILED DESCRIPTION OF THE INVENTION

A process is provided for forming tube-shaped hollow bodies made of metal, particularly made of aluminum. After shaping of a slab-shaped semifinished product into a closed cross-sectional profile and straight seam welding of the opposing edges of the semifinished product to form a tube-shaped hollow body, the tube-shaped hollow body is mechanically partially expanded and/or mechanically partially reduced in an upstream processing phase, soft annealed, and finally hydroformed in a die by a medium introduced into the hollow body.

Through the upstream processing phase, the tube-shaped hollow body can already be impressed with a temporary cross-sectional shape which tends towards the final cross-

sectional shape. In this way, the maximum forming length is again made available for hydroforming by the subsequent soft annealing. Therefore, during the final hydroforming, a final cross-sectional shape, which is relative to the original cross-sectional form of the tube-shaped hollow body after straight seam welding significantly greater than the maximum values achievable until now, can be achieved.

According to a further development, the processing phases of mechanical partial expansion and/or mechanical partial reduction and subsequent soft annealing can be performed multiple times in sequence. In this way, even greater forming lengths can be achieved.

In addition, the tube-shaped hollow body can also be soft annealed before the upstream processing phase. In this way, hardening due to the shaping process into a closed tube is also eliminated and a high forming reserve for the upstream processing phase is achieved.

The partial expansion and/or reduction of the tube-shaped hollow body can be performed at those locations at which the largest alteration of the cross-section after hydroforming relative to the initial cross-section occurs.

Typical further processing phases, such as mechanical bending and mechanical forming, can be performed

between the processing phases of soft annealing and hydroforming.

In the following, the invention will be described with reference to [the drawing.] FIG. 1, which [This] shows a sequence of sequential processing phases schematically.

The starting point is a tube-shaped hollow body 10 made of aluminum with a constant annular cross-sectional area, as is illustrated in FIG. 1(a).

This hollow body 10 is now partially expanded by a processing tool, in this case by a conical mandrel 12, which is driven axially into the hollow body 10. For performing expansion only within the tube-shaped hollow body 10, an expandable mandrel can be used which is first inserted, then expanded, and then driven further axially over a limited path.

Subsequently, the expanded hollow body 10', as illustrated in FIG. 1(b), is soft annealed at approximately 300°C.

After possible further processing phases, such as bending and/or mechanical forming, hydroforming is performed in a die 14.

For this purpose, the expanded hollow body 10' according to FIG. 1(c) is placed in the die 14, whose

internal cavity represents the future external dimensions of the hollow body 10'.

After a medium 16 is poured in and pressure is applied by the stamp 18, forming into the final shape of the hollow body 10" according to FIG. 1(d) then occurs.



B. MARKED UP VERSION OF THE ABSTRACT SHOWING CHANGES MADE

ABSTRACT

A process for forming tube-shaped hollow bodies made of metal, particularly made of aluminum, is described. [

]__After forming a slab-shaped semifinished product into a closed cross-sectional profile and straight seam welding the opposing edges of the semifinished product, the tube-shaped hollow body is first mechanically partially expanded and/or mechanically partially reduced in an upstream processing phase. It is then soft annealed and finally hydroformed in a die by a medium introduced into the hollow body.